Establishing an evidenced-based dietetic model of care in haemodialysis using implementation science

Mackay, Hannah J; Campbell, Katrina L; van der Meij, Barbara S; Wilkinson, Shelley A

Published in:
Nutrition and Dietetics

DOI:
10.1111/1747-0080.12528

Establishing an evidenced-based dietetic model of care in Haemodialysis using implementation science

Running title: EBP haemodialysis dietetic service implementation

Author names

Hannah J Mackay[1], Katrina L Campbell[2], Barbara S van der Meij[1,2,3], Shelley A Wilkinson [1,3].

Hannah J Mackay, BNutr&Diet (Hons), APD, Dietitian, Mater Health

Katrina L Campbell, BNutr&Diet (Hons), PhD, Associate Professor Bond University, AdvAPD, Senior Research Fellow Queensland Health

Barbara S van der Meij, BNutri&Diet, Msc Nutrition & Health, PhD, Conjoint Senior Research Dietitian, Mater Health and Bond University

Shelley A Wilkinson, BSc, BPsych (Hons), GradDipNutr&Diet, PhD, AdvAPD, Senior Research Dietitian, Mater Health/Mater Research

Author affiliations

[1]Department of Dietetics & Foodservices, Mater Health, South Brisbane, Queensland

[2]Faculty of Health Sciences and Medicine, Bond University, Robina, Gold Coast, Queensland

[3]Mater Research Institute -University of Queensland, Brisbane, Queensland

Authorship Declaration

HM lead the project and collected data. HM and BM analysed data. KC and SW supervised the project. All authors contributed to interpretation of results, and revision of the manuscript.

All authors are in agreement with the manuscript and declare that the content has not been published elsewhere.

The authors would like to thank Dr. Michael Burke and Dr. Richard Baer (Department of Nephrology, Mater Health), Shimbie Lewis (Fresenius Medical Care), Anne Jackson and Kelly Willersdorf (Mater Education), Cameron Hurst and Satomi Okano (QIMR Berghofer Medical Research Institute), and Mater Foundation.

Funding statement

This research did not receive any grant funding.

Conflicts of Interest statement

The authors declare no conflict of interest.

Word count: 3851

Number of tables: 2

Number of figures: 1

Abstract

Aim: To establish an evidence-based dietetics service in an in-centre haemodialysis unit utilising Implementation Science.

Methods: The service was developed through the Knowledge-to-Action Framework. The steps of the Action Cycle were addressed through a literature review, identification of evidence-based guidelines, benchmarking, and local staff engagement. The theoretical domains framework (TDF) was used to identify barriers/enablers, and behaviour change wheel to determine appropriate interventions. To monitor, evaluate outcomes, and assess sustained knowledge use we employed multidisciplinary team engagement and database use. Audit data were collected at baseline, 6 and 12 months on nutrition assessment (Patient-Generated Subjective Global Assessment), intervention timeliness, and alignment to dietetic workforce recommendations. Descriptive statistics, McNemar tests, and a linear mixed model were applied.

Results: Barriers existed in the knowledge, skills, environmental context and resources TDF domains. Suitable interventions were identified with training on nutritional management of haemodialysis patients delivered to 148 nurses, and nutrition management recommendations summarised into local procedural resources. A database to prompt and monitor outcome measures was created and indicated that over 18 months post service commencement, eligible patients received nutrition assessment at least 6-monthly, aligning with recommendations. Prevalence of malnutrition was 28% (n=9/32) at baseline, 23% (n=5/22) at 6 months, and 20% (n=4/20) at 12 months (p= 0.50).

Conclusions: We demonstrated benefits to service development and implementation with implementation science providing a structured and methodical approach to translating guidelines into practice. Development of training, resources and prompts for outcome measures has supported the establishment of an evidence-based dietetics service in a haemodialysis unit.

Key words: Renal, clinical nutrition and dietetics, malnutrition, evidence based practice

Introduction

The increasing prevalence of Chronic Kidney Disease (CKD) is a global health problem causing high burden on patients and the health care system. In Australia prevalence of

CKD is around 10% which equates to approximately 1.7 million Australian adults with CKD.[1,2] Nutrition care is vital for all people with CKD, not only for assisting in management of electrolyte disturbances, fluid balance, mineral and bone disorders, but also to prevent and manage protein-energy wasting (PEW).[3] PEW is highly prevalent in haemodialysis patients (up to 64%),[4] and is predictive of increased morbidity and mortality in CKD.[3,5] Therefore, monitoring and management of PEW is essential in the haemodialysis population.

Various national and international evidence-based guidelines are available to guide nutrition management during haemodialysis.[3,6-11] Additionally, there are Australian workforce recommendations[12] and state government demand-management protocols known as “Frameworks for Effective and Efficient Dietetics Services” (FEEDS)[13] to guide practice. Implementation of these evidence-based nutrition guidelines is associated with improved nutrition status and reduced rates of malnutrition which is linked to mortality in haemodialysis patients.[14,15]

Despite the existence of evidence-based nutrition guidelines, failure to routinely translate evidence into clinical practice is a common finding in health services.[16] Awareness and dissemination of guidelines alone does not always change practice and the assessment of influencing factors (barriers and enablers) and implementation and evaluation design should be systematic and theory-driven.[17,18] Barriers for implementing CKD evidence-based guidelines have been identified in surveys with specialist renal dietitians in Australia and New Zealand, with barriers being a perceived lack of time, skills/self-efficacy, and inefficient referral systems relating to lower rates of guideline implementation.[19] Inadequate staffing has been identified as a barrier in the provision of appropriate care with various renal services having inadequate staffing allocations to meet recommendations.[12]

This paper describes the planning and implementation of a new nutrition service at an in-centre haemodialysis unit established at a metropolitan tertiary hospital in Queensland. The process undertaken to translate haemodialysis nutrition guidelines into practice in the establishment of an evidence-based haemodialysis model of care used an Implementation Science approach. Specifically, this project aimed to follow the Knowledge-to-Action (KTA) cycle,[20] theoretical domains framework (TDF)[21] and behaviour change wheel (BCW)[22] to apply evidence in a local setting following an assessment of barriers and enablers, designing of effective interventions supported by routine monitoring, and evaluation processes.

Methods

This project was commenced in September 2016 to meet the needs of a new in-centre haemodialysis service, with a total of twelve dialysis chairs for both public and private health funded patients, available for morning and evening shifts, opening November 2016. To develop, implement, and evaluate our haemodialysis model of care we applied the KTA which is an iterative approach that allows building (Knowledge Creation) and application of knowledge (Action Cycle).[23] The steps of the Action Cycle can occur sequentially or concurrently and involve identification of the problem, assessing knowledge use determinants, evaluating the impact of knowledge use or outcomes, and ensuring sustainability.[20] In this project assessment and intervention selection required use of the integrative TDF[21] and BCW;[22] the TDF as a system for defining barriers, and the BCW as a system for guiding decision-making around designing behaviour change interventions based on the barriers.[22,24]

The action cycle process of problem identification involves reviewing and selecting knowledge, then adapting knowledge to the local context. Therefore, renal nutrition guidelines were identified by a literature search through Pubmed, CINAHL, Scopus, Web of Science, Google Scholar with publications in the last five years, however key guidelines were later included up to twelve years after publication.[3,6,7,9-11,25,26] We systematically mapped our clinical service and collated the best available evidence for the clinical area using Nutrition Care Process Terminology.[27] Service mapping and comparisons included benchmarking with external haemodialysis centres regarding models of care such as current inpatient and outpatient dietetic procedures, referral and monitoring processes, and training programs. Engagement with management and staff internal (Nephrologists, Nursing, Mater Education) and external (Fresenius – a service partner) was undertaken to define the wider service plan, including expected capacity with patient numbers, time frames for dialysis and possible service expansion plans.

Assessment of knowledge use determinants, specifically barriers to knowledge use, was conducted through clinic observation, along with team discussion with key partners including management, Nephrologists, and local dietitians, with information collection about current practices, the service plan, and identification of potential barriers prior to haemodialysis service commencement. Barriers were categorised and defined using the TDF which includes the twelve domains; knowledge, skills, social/professional role and identity, beliefs about capabilities, beliefs about consequences, motivation and goals, memory and decision processes, environmental context and resources, social influences, emotion, behaviour regulation, and nature of the behaviours. Application of the BCW was to be used to determine intervention appropriateness for the barriers and enablers identified with the TDF domains.[22]

In order to monitor knowledge use, evaluate outcomes, and sustain knowledge use a database was created for dietitian use, and analysed six-monthly. Data was collected as an audit to define the population and demonstrate effectiveness of the service change. Data included outcome measures of malnutrition prevalence as assessed with the PG-SGA category (categorised as A: well-nourished, B: moderately malnourished, or C: severely malnourished), and numerical score (range 0 to 50, with lower score indicating reduced malnutrition risk),[28] timeliness of intervention after commencing haemodialysis, and overall dietitian time allocation and number of occasions of service as extracted from the Team Allied Health Data Information System. The dietitian full-time equivalent (FTE) for the haemodialysis unit was compared to those in workforce recommendations suggesting 1 FTE for every 100 haemodialysis patients.[12] The dietitian would also see patients undergoing haemodialysis short-term or who were admitted on inpatient wards, however these were not included in general data collection.

A database was developed for the dietitian to record patient demographics, PG-SGA scores, consult dates and prompts for future reviews for patients attending the haemodialysis service. There were automatic referrals for all new patients to the service, and reviews were determined by the dietitian or requested from the multidisciplinary team. All patients that attended the service during the 18 months following opening were assessed including with a PG-SGA, with an aim to be completed within one month of commencing haemodialysis and a minimum of six-monthly thereafter as usual care. Data were audited and analysed six-monthly however data were excluded from analysis for patients that were dialysing short-term, palliative, admitted to alternative tertiary hospitals, or discharged from the service in less than six months.

Patient characteristics including age, gender, and public or private funding source, were presented using descriptive statistics, with means and standard deviations used for continuous variable, if normally distributed, and median and interquartile ranges otherwise. Categorical variables were described using counts and percentages. For the outcome, PG-SGA category (A: well-nourished, or, B and C: moderately and severely malnourished) as a binary variable, we considered baseline and after 12 months with McNemar test used to test for an association. As outcome PG-SGA score was both continuous and repeatedly measured over time we used a linear mixed model to account for the correlated longitudinal nature of data. All analysis was conducted using SPSS for Windows version 24. A significance level of 0.05 was used throughout all inferential analysis.

This study received exemption from ethical approval from the hospital's Human Research Ethics Committee (HREC/18/MHS/90).

Results

Assessment of barriers identified the main TDF domains to be knowledge, skills, and environmental context and resources as detailed further in Table 1. Interventions were developed to address barriers with appropriateness determined from use of the BCW.[24] These interventions have been operationalised as various strategies shown in the final column in Table 1.

Evidence-based guidelines for nutritional management of haemodialysis patients were identified and summarised into a local document to assist the dietitian gain knowledge and guide the nutrition care process and training content.[3, 6-11]

Training was a key intervention function to address knowledge and skills barriers for nursing and dietetics. This was undertaken in ten identical face-to-face training workshops conducted with a total of 148 nursing staff from both public and private hospital sectors as haemodialysis patients would be both public and privately funded. The nutrition component of the workshops involved a 25-minute presentation with session topics including the various nutrition components for haemodialysis patients, the role of the dietitian and when to refer patients to the dietitian. The nutrition component was developed alongside various other components relevant to the care of patients with chronic kidney disease including the patient journey, pharmacological considerations, nursing and fistula care. The workshop was complimented by development of an online learning guide for nursing staff which is being reviewed by a team of health professionals including doctors, clinical educators, nursing staff, pharmacists, and the renal dietitian, for future education program use. This learning guide included nutritional management of haemodialysis patients, pathways for dietitian referrals, along with other aspects of nursing care for haemodialysis patients.

A one-off presentation was also prepared for professional development of all Nutrition and Dietetic department dietitians. This presentation described the dialysis unit including number of dialysis chairs, potential patient numbers, timing of dialysis, and the role of nutrition in haemodialysis with NCP components expanded on from the nursing nutrition module.

Service design included involvement in multi-disciplinary processes such as meetings, monthly blood review (with Nephrologist, Pharmacist, Nursing), and education strategies for both staff and patients. The dietitian was involved in mentoring and peer reviewing to further ensure knowledge and skills barriers were addressed. The haemodialysis dietetic service was also integrated into a Nutrition and Dietetic department strategy of regular evaluation and reporting.

Figure 1 shows the patient flow during the 18-months of haemodialysis service. There was a total n=33 eligible patients that attended the haemodialysis service over the eighteen months following service commencement. Outcome measures were collected with n=32 at baseline, and n=22 and n=20 at six and 12 months respectively. There were incomplete malnutrition data for a total of two patients (n=1 at baseline, and n=1 at six-month follow-up), and a total of n=27 were excluded over the period from November 2016 to May 2018, with 63% (n=17/27) that left the service with continued dialysis at alternative sites. Patients that did not meet eligibility were still seen by the dietitian as part of usual care however data were not included in analysis.

The mean age of the haemodialysis population was 63.7 (SD=16.8) years and 52% (n=17/33) of these patients were male. A majority of patients (93.9%, n=31/33) were public patients. A total of 48.5% (n=16/33) of the patients included were new to dialysis; commencing dialysis for the first time at the service. In the initial 18 months following service establishment, 100% of patients received dietetics assessment as part of usual care.

All haemodialysis patients were seen for nutrition assessment including a PG-SGA in the 6-monthly time-points and a priority was placed on nutrition assessment of newly commencing haemodialysis patients.

Initial assessment with use of PG-SGA was completed 24.0 (SD=23.4) days after commencing at the dialysis unit, with repeat measures at 6.0 (SD=1.5) months, and 11.8 (SD=1.6) months. Included within the 12-month PG-SGA data were two outliers that received assessment of PG-SGA at 9-months post- commencing at the service however they were included as nutrition guidelines recommend minimum of six-monthly assessment. Of patients new to dialysis, 88% (n=14/16) were seen within one month of commencing dialysis.

Malnutrition prevalence is detailed in Table 2. There was no statistical change in malnutrition categories or score over the 12 months (P=0.45), with the majority of patients (72-80%) being well nourished from commencement and at all time-points. While a decrease in PG-SGA score was seen in our sample, with an average PG-SGA score of 6.2 (95% CI: 4.6-7.8) at baseline, 5.3 (95% CI: 3.5-7.2) at six-months, and 4.8 (95% CI: 2.8-6.7) at 12 months, this was not statistically significant (P=0.49).

The dietitian was allocated initially a 0.3 FTE to provide service for a total of 23 patient (equivalent of 1.30 FTE to 100 haemodialysis patients) and this increased over the 18 months to 0.4 FTE for a total of 29 patients (equivalent of 1.38 FTE to 100 haemodialysis patients), however the allocation also included the additional time provided for service development and inpatient renal nutrition care. On average over the 18 month period greater than 87% of dietitian time was face-to-face or patient-related activity. There was an increased review frequency for patients that were malnourished, requiring weight management for renal transplant eligibility, requiring nutrition education and counselling due to nutrition-related abnormal biochemistry or fluid control.

Discussion

Following an IS approach we successfully developed, implemented and evaluated an evidence-based haemodialysis dietetic service. This approach allowed for targeted nutrition education and training interventions for staff, and clearly defined dietetic service processes and procedures, with NCP components detailed and adapted for the local context. A mechanism prompting routine monitoring of outcomes has also been adopted into usual care, allowing for easier regular evaluation with continuation of the KTA cycle. Subsequently, the development and implementation of the service has resulted in haemodialysis patients receiving nutrition assessment within appropriate time-frames (a minimum of 6-monthly) as recommended in evidence-based guidelines.[9] The service has had sufficient dietetic staffing levels, with additional FTE provided above the workforce recommendations allowing for service development and expected service growth. The initial education and training with nursing is planned to be repeated and further review of the online module to assist with sustaining knowledge and skills.

For patients attending the evidence-based haemodialysis dietetic service, the majority (72-80%) have been well-nourished. The malnutrition prevalence in the current population was low from commencement and through all included time-points. The reason for malnutrition prevalence prior to attending the service can not be commented on however alternative variables impacting malnutrition prevalence may be an area for further research. The literature suggests malnutrition prevalence in the haemodialysis populations of up to 64%,[4] however implementation of evidence-based practice in previous studies has shown beneficial clinical outcomes on malnutrition prevalence.[15] Another study implementing evidence-based practice in a haemodialysis population showed a decrease in malnutrition prevalence from 14% at baseline to 3% in three years.[15] This study had similar demographics, however had a higher ratio of private facility patients, and excluded patients that had been undergoing dialysis for less than three months where the current study included patients new to haemodialysis. The PG-SGA data assists in explaining the population, aligns with similar research and as many renal services routinely monitor malnutrition prevalence six-monthly, the data may assist for comparison and benchmarking.

Although initial outcome measures were aiming to achieve the minimum of 6-monthly assessment, there was further collaboration and attendance at monthly blood reviews and multi-disciplinary meetings to ensure avenues for communication, close monitoring of biochemistry, and prompting for more regular reviews if indicated. This open communication is seen as an enabler for the referral process which has otherwise been suggested as a potential barrier in previous research.[19] Furthermore, support from management and higher dietetic FTE than the 1:100 haemodialysis patients recommended in workforce guidelines assisted in the ability to use the IS approach and was an enabler to perceived time barriers that have been identified by other renal dietitians for nutrition guideline implementation.

However, during the initial 6-month period there were two occasions of nutrition assessment of new dialysis patients being prolonged further than the one month suggested by Fouque et al [8]. This was identified and created further understanding of processes and the potential barrier of reduced workforce over public holidays and the need to ensure appropriate predictions for these times.

The current dietetics service aligns with the Framework for Effective and Efficient Dietetic Services (FEEDS) recommending patients be seen a minimum of 6-monthly with use of a nutrition assessment tool such as SGA or PG-SGA.[13] The FEEDS document also prioritises referral reasons, recommends experienced dietitians or mentoring, and similarly provides references for evidence-based guidelines, all of which were incorporated into local work area resources. However, this study provides further detail on implementation of evidence-based guidelines into dietetic practice with the use of frameworks as an example to allow for an iterative process for others.

The strength of this study is the systematic application of frameworks such as the KTA, TDF and the BCW in planning the implementation of the new model of care. Use of theory and frameworks has been shown to be more effective than projects based on intuition.[29,30] Further strengths include the structured approach to implementation of evidence-based guidelines in service development, which allows for future research, wider collaboration, and assistance in streamlining services. This IS approach may provide an example for other similar dietetic services establishing or implementing an evidenced-based model of care. Limitations include the small sample size which impacts the ability to detect statistically significant changes in measured outcomes. However, these will continue to be routinely evaluated to obtain an ongoing measure of our service effectiveness and will allow planning of data-informed, iterative service changes, as required. Further limitations relate to the lack of access to the evaluation of knowledge transfer to nursing staff after training, patient satisfaction and consumer engagement during the service development. However, this has been acknowledged and will be completed in future training and education, and service provision has also included a structured plan for patient satisfaction and consumer engagement.

As part of our department's wider commitment to delivering evidence-based care through continual application of the KTA cycle we plan to monitor the services identified outcomes 6-monthly and develop our service and incorporate new evidence into our practice as literature becomes available, as required. Furthermore, it is acknowledged that guidelines are only as robust as the research that informs them and call for ongoing Knowledge

Creation activities to enhance the delivery of evidence-based nutrition care in haemodialysis.

Conclusion

We have demonstrated the benefits to service development and implementation that can results from the use of IS frameworks and models (KTA, TDF, BCW) to translate evidence-based guidelines into practice. These tools have enabled a structured and methodical approach to both establishment and continued implementation of the service over time. Key interventions including training, local resource development, and a working database embedding monitoring and evaluation of outcome measures into practice has resulted in maintenance of nutrition status over the 18 months following service commencement. There is a plan to continue these processes with ongoing monitoring and evaluation and use of these frameworks and implementation science as the service grows. Further research needs to be conducted in evaluation of training programs, consumer feedback, and alternative variables impacting malnutrition prevalence.

References

1 Australian Institute of Health and Welfare. Chronic kidney disease compendium [Web report]; 2017. (Available from: https://www.aihw.gov.au/reports/chronic-kidney-disease/chronic-kidney-disease-compendium/data, accessed 2 September 2018).

2 International Society of Nephrology. Global Kidney Health Atlas; 2017. (Available from: www.theisn.org/global-atlas, accessed 2 September 2018).

3 Kopple JD. National kidney foundation K/DOQI clinical practice guidelines for nutrition in chronic renal failure. *Am J Kidney Dis* 2001; **37**(1 Suppl 2): 66-70.

4 Campbell K, Ash S, Bauer J et al. Critical review of nutrition assessment tools to measure malnutrition in chronic kidney disease. *Nutrition & Dietetics* 2007; **64**(Supp 1): 23-30.

5 Pifer TB, Mccullough KP, Port FK et al. Mortality risk in hemodialysis patients and changes in nutritional indicators: DOPPS. *Kidney Int* 2002; **62**: 2238-45.

6 Noordzij M, Korevaar JC, Boeschoten EW et al. The Kidney Disease Outcomes Quality Initiative (K/DOQI) Guideline for Bone Metabolism and Disease in CKD: association with mortality in dialysis patients. *Am J Kidney Dis* 2005; **46**(5): 925-32.

7 Wright M, Jones C. Renal Association Clinical Practice Guideline on nutrition in CKD. *Nephron Clin Pract* 2011; **118**(Suppl 1): 153-64.

8 Fouque D, Pelletier S, Mafra D, Chauveau P. Nutrition and chronic kidney disease. *Kidney Int* 2011; **80**(4): 348-57.

9 Ash S, Campbell K, MacLaughlin H et al. Evidence based practice guidelines for the nutritional management of chronic kidney disease. *Nutrition & Dietetics* 2006; **63**: 35-45.

10 Naylor HL, Jackson H, Walker GH et al. British Dietetic Association evidence-based guidelines for the protein requirements of adults undergoing maintenance haemodialysis or peritoneal dialysis. *J Hum Nutr Diet* 2013; **26**(4): 315-28.

11 British Dietetic Association Renal Nutrition Group. Evidenced Based Dietetic Guidelines Protein requirements of Adults on Haemodialysis and Peritoneal Dialysis, 2011.

12 The Australian and New Zealand Renal Dietitians Workforce Planning Group. Workforce recommendations for renal dietitians in Australia and New Zealand, 2012 (Available from: https://daa.asn.au/wp-content/uploads/2018/11/Renal-Dietitians-Workforce-Recommendations.pdf, accessed 5 September 2016).

13 Queensland Health. Framework for Effective and Efficient Dietetics Services: An Evidenced-Based Demand Management Toolkit for Dietetics Services; 2017 (Available from: https://www.health.qld.gov.au, accessed 1 August 2017).

14 Lopes AA, Bragg-Gresham JL, Elder SJ et al. Independent and joint associations of nutritional status indicators with mortality risk among chronic hemodialysis patients in the Dialysis Outcomes and Practice Patterns Study (DOPPS). *J Ren Nutr* 2010; **20**(4): 224-34.

15 Campell K, Ash S, Zabel R et al. Implementation of Standardized Nutrition Guidelines by Renal Dietitians Is Associated with Improved Nutrition Status. *J Ren Nutr* 2009; **19**(2): 136-44.

16 Grimshaw J, Eccles M, Tetroe J. Implementing clinical guidelines: Current evidence and future implications. *J Contin Educ Health Prof* 2004; **24**: 31 - S7.

17 Grol R, Wensing M. What drives change? Barriers to and incentives for achieving evidence-based practice. *BMJ* 2004; **180**: 57-60.

18 French SD, Green SE, O'Connor DA et al. Developing theory-informed behaviour change interventions to implement evidence into practice: a systematic approach using the Theoretical Domains Framework. *Implement Sci* 2012; **7**: 38.

19 Hall-McMahon EJ, Campbell KL. Have renal dietitians successfully implemented evidence-based guidelines into practice? A survey of dietitians across Australia and New Zealand. *J Ren Nutr* 2012; **22**(6): 584-91.

20 Straus S, Tetroe J, Graham I. *Knowledge translation in health care. Moving from evidence to practice*. Oxford: Wiley-Blackwell/BMJ Books, 2009.

21 Francis J, O'Connor D, Curran J. Theories of behaviour change synthesised into a set of theoretical groupings: introducing a thematic series on the theoretical domains framework. *Implement Sci* 2012; **7**: 35.

22 Michie S, van Stralen M, West R. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implement Sci* 2011; **6**: 42.

23 Graham ID, Logan J, Harrison MB, Straus SE, Tetroe J, Caswell W. Lost in knowledge translation: time for a map? *J Contin Educ Health Prof* 2006; **26**(1): 13-24.

24 Colquhoun H, Leeman J, Michie S et al. Towards a common terminology: a simplified framework of interventions to promote and integrate evidence into health practices, systems and policies. *Implement Sci* 2014; **9**: 51.

25 Johnson DW, Atai E, Chan M et al. KHA-CARI guideline: Early chronic kidney disease: detection, prevention and management. *Nephrology (Carlton)* 2013; **18**(5): 340-50.

26 Wiggins KL, Harvey KS. A review of guidelines for nutrition care of renal patients. *J Ren Nutr* 2002; **12**(3): 190-6.

27 Academy of Nutrition and Dietetics. About eNCPT 2017. (Available from: https://www.ncpro.org//default.cfm, accessed 10 February 2017).

28 Ottery FD. Patient-Generated Subjective Global Assessment In: *The Clinical Guide to Oncology Nutrition ed.* Chicago: The American Dietetic Association, 2000.

29 Albarracin D, Gillette J, Earl A et al. A Test of Major Assumptions About Behavior Change: A Comprehensive Look at the Effects of Passive and Active HIV-

Prevention Interventions Since the Beginning of the Epidemic. *Psychol Bull* 2005; **131**: 859-97.

30 Chang AM, Crowe L. Validation of scales measuring self-efficacy and outcome expectancy in evidence-based practice. *Worldviews Evid Based Nurs* 2011; **8**:106-15.

Table 1. Overview of the application of the Knowledge to Action (KTA) framework, linked with identified barriers/enables for the proposed haemodialysis service, paired with interventions and strategies to operationalise interventions

Knowledge-to-Action cycle[20]	**Identified barriers (TDF domain)**[21]	**Enablers**	**Intervention function (from BCW)**[22]	**Intervention function operationalised as strategies**[24]
Identify problem/identity, review, select knowledge	No previous service therefore assumed limited knowledge of nutrition management during dialysis for dietetics and nursing staff (Knowledge)	Goals with guidelines to specify details of nutrition care process and workforce and external sites to model or benchmark	Psychological capability	1. Comparison with alternate dialysis sites dietetic service (modelling) 2. Literature review informing procedures and outcome measures from identified evidence-based nutrition guidelines 3. Knowledge and skills-based training with nursing staff and dietetics
Assess barriers to knowledge use	No existing haemodialysis service Time barrier for dietetics (environmental context and resources)	Defined nutrition care 'goals' or outcome measures from literature Recommendations around dietetic staffing as per literature[12] Management support in providing recommended staffing	Psychological capability Physical opportunity	1. Development of local documents detailing NCP components for nutrition and haemodialysis and incorporating into development of local processes/procedures 2. Creation of dietetic database with outcome measures and prompts for review and service provision 3. Determining FTE and dietetic allocation provided
Select, tailor, implement interventions	No previous service therefore assumed limited knowledge for dietetics and nursing staff (Knowledge, skills, beliefs about capabilities)	Interest in learning and engagement from management and Mater Education	Psychological capability Physical opportunity	1. Training packages for nursing staff and dietitians 2. Mentoring with identified experienced renal dietitians 3. Personal upskilling
Adapt knowledge to local context	No previous experience in knowledge to action process for the renal dietitian (Cognitive Skills)	Commencement of new service so no previous local context or beliefs	Psychological capability	1. Professional development and personal upskilling 2. Peer reviewing 3. Mentoring
Monitor knowledge use	No local dietetic processes in place (environmental context and resources)	Defined nutrition care process and goals from literature	Physical capability	1. Monitoring of outcome measures 2. Reporting outcome measure to key stakeholders
Evaluate outcomes Sustain knowledge	No haemodialysis dietetic model of care in place	Dietetic department with focus in evidence-base practice and regular	Physical opportunity	1. Creation of database with outcome measures and prompts for review and

This is the peer reviewed version of the following article: Mackay, H. J., Campbell, K. L., van der Meij, B. S., & Wilkinson, S. A. (2019). Establishing an evidenced-based dietetic model of care in haemodialysis using implementation science. Nutrition and Dietetics, 76(2), 150-157, which has been published in final form at https://doi.org/10.1111/1747-0080.12528.

use	(Environmental context and resources)	monitoring and evaluation processes in place and encouraged		service provision 2. Involvement in MDT processes such as meetings, monthly blood review (with Nephrologist, Pharmacist, nursing), education strategies (nursing, patient, and dietetics) 3. Integration of haemodialysis dietetic service into department reporting and strategy planning

Table 2. Malnutrition prevalence of haemodialysis patients at baseline, 6-months, and 12-months following commencement at the service

	Baseline	six-month	12-month	P-value
Total patients (N)	32	22	20	
PG-SGA Category (N)				0.45[1]
- A (Well nourished)	23 (71.9%)	17 (77.3%)	16 (80.0%)	
- B (Moderately malnourished)	8 (25.0%)	4 (22.7%)	4 (20.0%)	
- C (Severely malnourished)	1 (3.1%)	0		
PG-SGA Score	6.2[2] (95%CI: 4.6-7.8)	5.3 (95%CI: 4.6-7.8)	4.8 (95%CI: 2.8-6.7)	0.49[3]

[1] McNemar test based on two categories (PG-SGA A: well-nourished, PG-SGA B and C: moderately and severely malnourished) with baseline and 12 months follow-up

[2] Missing score for n=3

[3] Linear Mixed Model